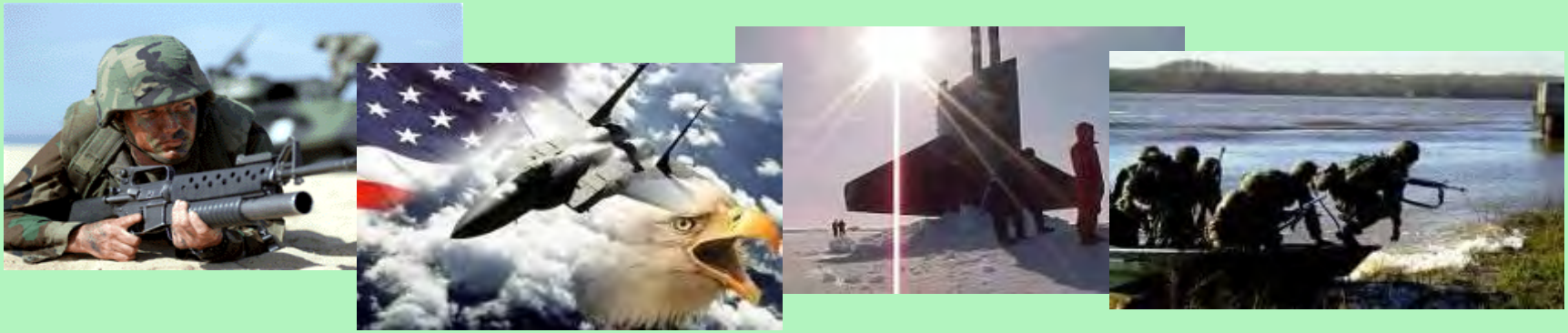
The Defense Logistics Agency



DLA's Hydrogen Fuel Cell Pilots

E^2S^2 Conference

May 7, 2009

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Agenda

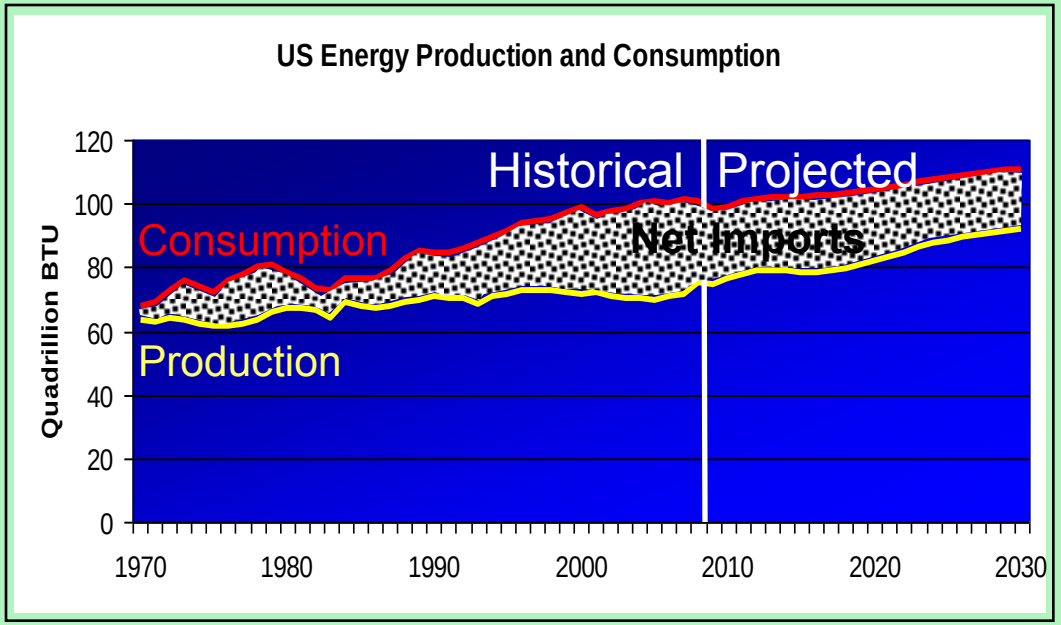
- The implications of energy use
  - Supply sustainability
  - Environmental sustainability
- Hydrogen and fuel cells offer potential „green" solutions
- DLA"s efforts to measure and improve viability of fuel cells

DoD is supporting long term solutions through early adoption of fuel cells

Energy Challenges

The U.S. and DoD (and the World) face serious energy concerns:

- Unsustainable use of conventional energy sources
  - Increasing population and energy demand
  - Tightening supplies
  - = resource depletion and high co$t
- Greenhouse Gas impacts
  - Conventional energy consumption responsible for 86% of GHG emissions



Sources: EIA *Annual Energy Review 2007* and *EIA Annual Energy Outlook 2009*

Energy Challenges – Climate Change

GHG emissions from forklift operations:

–Batteries: coal & natural gas

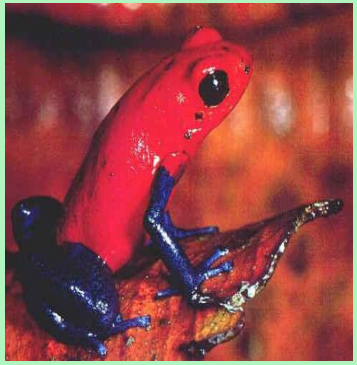
–Internal Combustion: diesel and propane

Environmental impacts:

–Sea level rise

–Weather intensity: heat, cold, drought storms

–Habitat destruction and biodiversity loss



Security implications:

–Threat multiplier in unstable regions

–Increased famine and disease

–Food and water pressures

–Environmental refugees

Solutions: Hydrogen and Fuel Cells

Hydrogen and fuel cells offer potential solutions as part of a portfolio of technologies

- Energy security:
  - Multiple domestic feedstocks
  - Potential for distributed generation
- Environmental Sustainability:
  - Can use renewables energy sources to generate „green" hydrogen

Solutions: there are no silver bullets!

Hydrogen Fuel Cell Basics

Energy production:
- Break H_2 bonds to generate electricity
- Byproducts: water & heat

Expensive Components:
- Fuel cell stacks
- Platinum catalyst

Potential Applications:
- Man portable power
- Automobiles
- Stationary backup power
- Large power systems

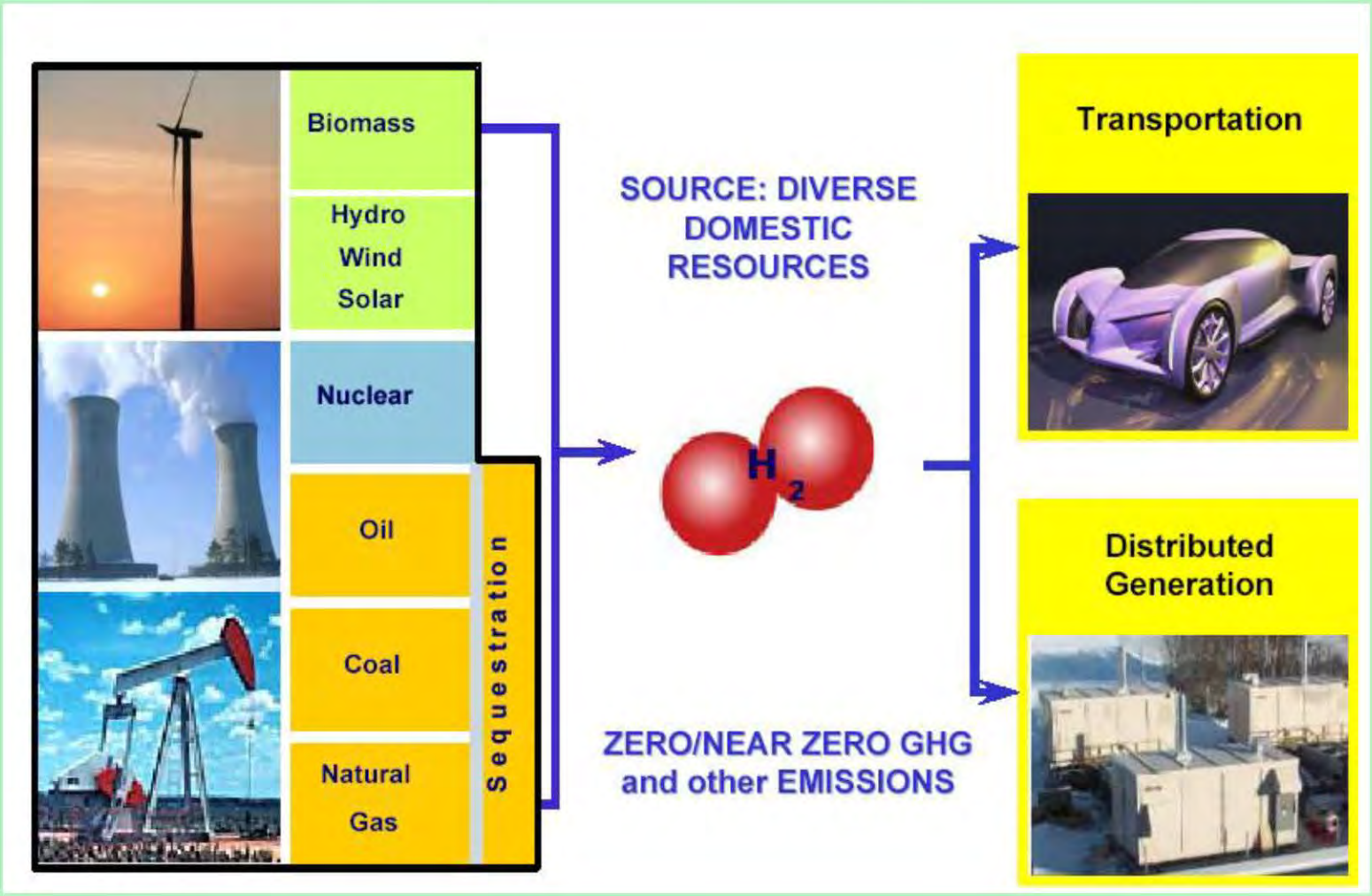
Hydrogen and Fuel Cell Benefits

Environmental sustainability:

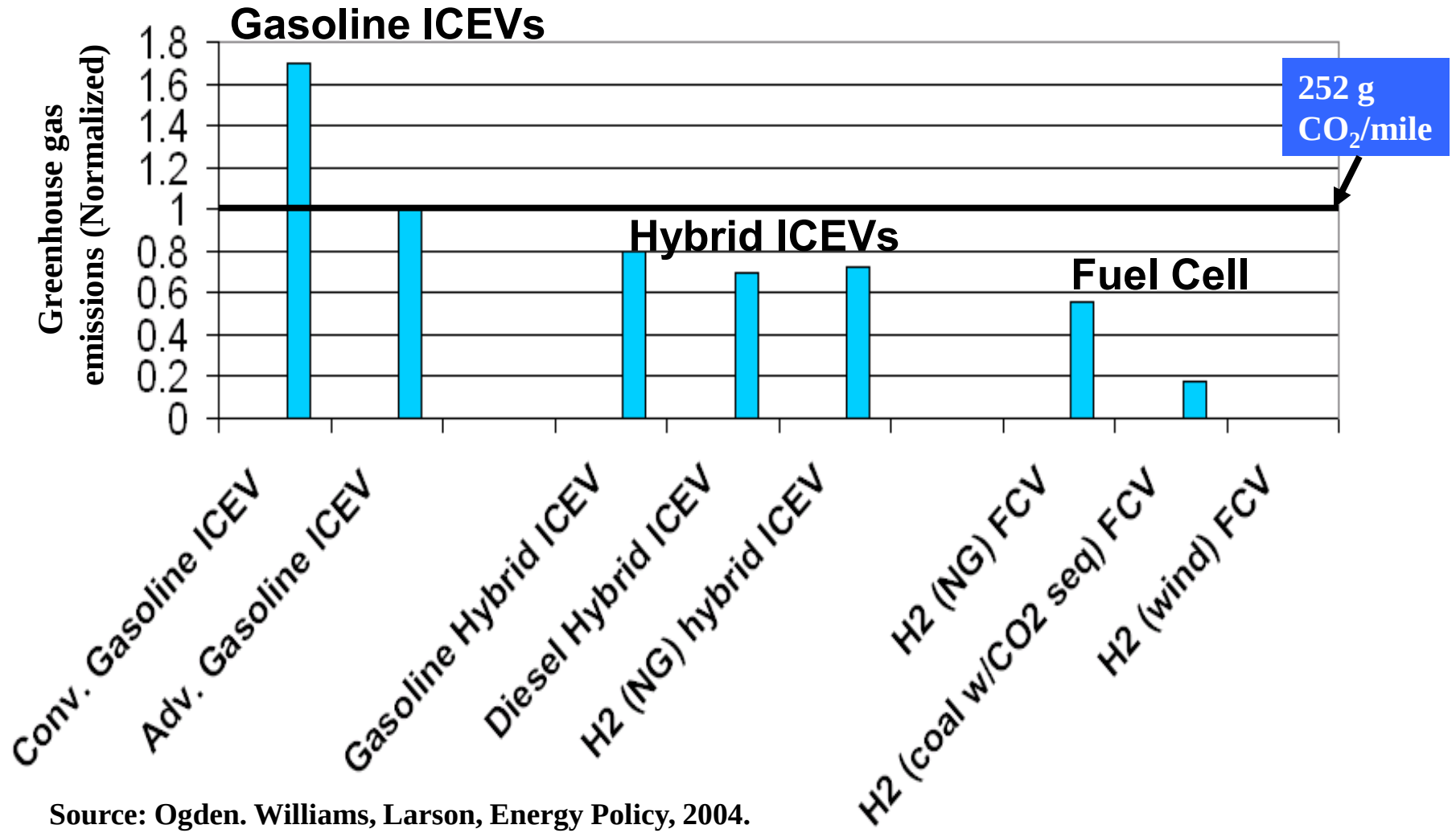
- Fuel cells are highly efficient:
  - Capture regenerative breaking
  - Hybrid systems using ultra capacitors or small batteries
  - Capture load lowering energy
- No fuel cell „tailpipe" emissions
- Potential for "green" hydrogen production pathway – zero GHG emissions

- Operational benefits over batteries
  - Rapid refueling
  - No battery management (changing, charging, disposing)
  - Constant power
- Fuel cell forklifts offer most value in three shift operations

Hydrogen Production Pathways



Hydrogen and Fuel Cells- Environmental Benefits



Source: Ogden. Williams, Larson, Energy Policy, 2004.
(Adv. Gasoline = 45 mpg, 252 g CO2/mile)

Hydrogen and Fuel Cells- Challenges

Many challenges to widespread use of the technologies:

- Cost
  - Fuel cells and hydrogen production
  - Even higher for „green" hydrogen technologies
- Fuel cell durability
- Hydrogen storage
  - Onboard storage capacity for long range capability
- Infrastructure
  - Fueling stations
  - Production
  - Distribution
- Public acceptance
- Switching from production pathways focused on conventional feedstocks

DLA's Strategy

Goals:

- Be an ***early adopter*** and ***principal demonstrator***
- Foster competition in the marketplace and provide a market demand
- Support improved Technology and Manufacturing Readiness Levels
  - –Exercise the supply chain
  - –Test under real world conditions
  - –Provide feedback to manufacturers
- Investigate the business case for fuel cells

Improve fuel cell readiness by funding R&D efforts in areas that are near commercialization

DLA's Hydrogen Projects – DDSP

Defense Depot Susquehanna, PA

- Ribbon Cutting: February 2009
- First of four 2-year demonstration projects
- Indoor dispensing system for delivered liquid H_2 (Air Products)
- Two fuel cell manufacturers (Plug Power and Deka/Nuvera)
  - Add 20 new fuel cell forklifts
  - Retrofit 20 forklifts with fuel cells
- National Renewable Energy Lab (NREL) to collect and analyze operational data
- Business case analysis compared to battery fork lifts

DLA's Hydrogen Projects – DDWG

Defense Depot Warner Robins, GA

- Ribbon Cutting: August 2009
- Equip 20 forklifts with fuel cells (Hydrogenics)
- H_2 reformed on site from natural gas (CTE/Air Products)
- Test mobile refueling
- Add to NREL data collection and analysis
- Add to business case analysis
- Teaming with Air Force Advanced Power Technology Office (APTO)

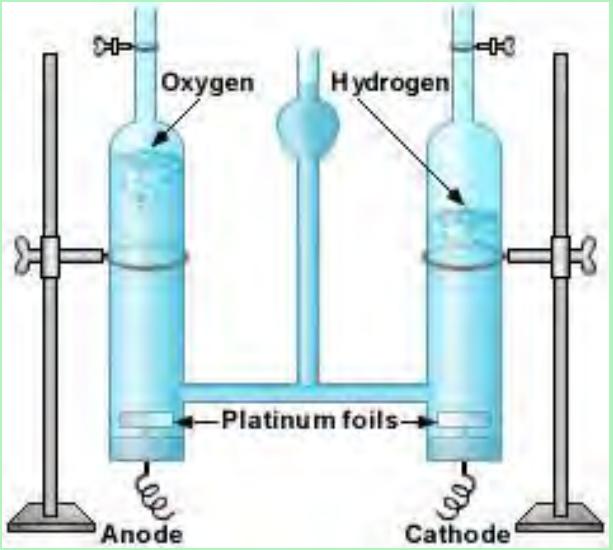
DLA's Green Hydrogen Projects – Ft. Lewis, WA

- Contract award: May 2009
- Operations start: Summer 2010
- 19 Fuel cell forklifts
- Fuel cell bus (potential partnership with AF)
- Wastewater Treatment Plant gas as the feedstock
  - Harnesses WWTP/GHG release that would typically occur
  - Avoids GHG emissions resulting from energy production for battery powered fuel cells
  - Hydrogen for forklift and bus
  - Mobile refueling
- More NREL data collection and analysis

DLA's Green Hydrogen Projects – DDJC

<u>Defense Depot San Joaquin, CA</u>

- Contract award: June 2009
- Operations start: Summer 2010
- Operations start:
- 20 Fuel cell forklifts to replace propane lifts
- Carbon-free on-site hydrogen production
  - Electrolysis using solar power
  - Power Purchase Agreement in partnership with DOE
  - Avoids GHG produced from propane combustion
- More NREL data collection and analysis
- Data points for business case vs. propane operations



Moving Forward

Solid Hydrogen Storage

- Teaming with DOE and other military Services for early stage R&D
- Phase I: Identify and design novel solid H_2 storage systems
- Phase II: build sub-scale prototypes for Defense applications
- Funding: $3M amongst 7 awardees in over 2007-2009

Extended Range Utility Vehicle

- Two phases: (I) design integrated novel H_2 storage to extend range of fuel cell utility, and (II) construct and integrate the technology at Warner Robins
  - Anticipated funding: $2 M amongst several awardees
  - BAA release: Summer 2009

Spiral Development

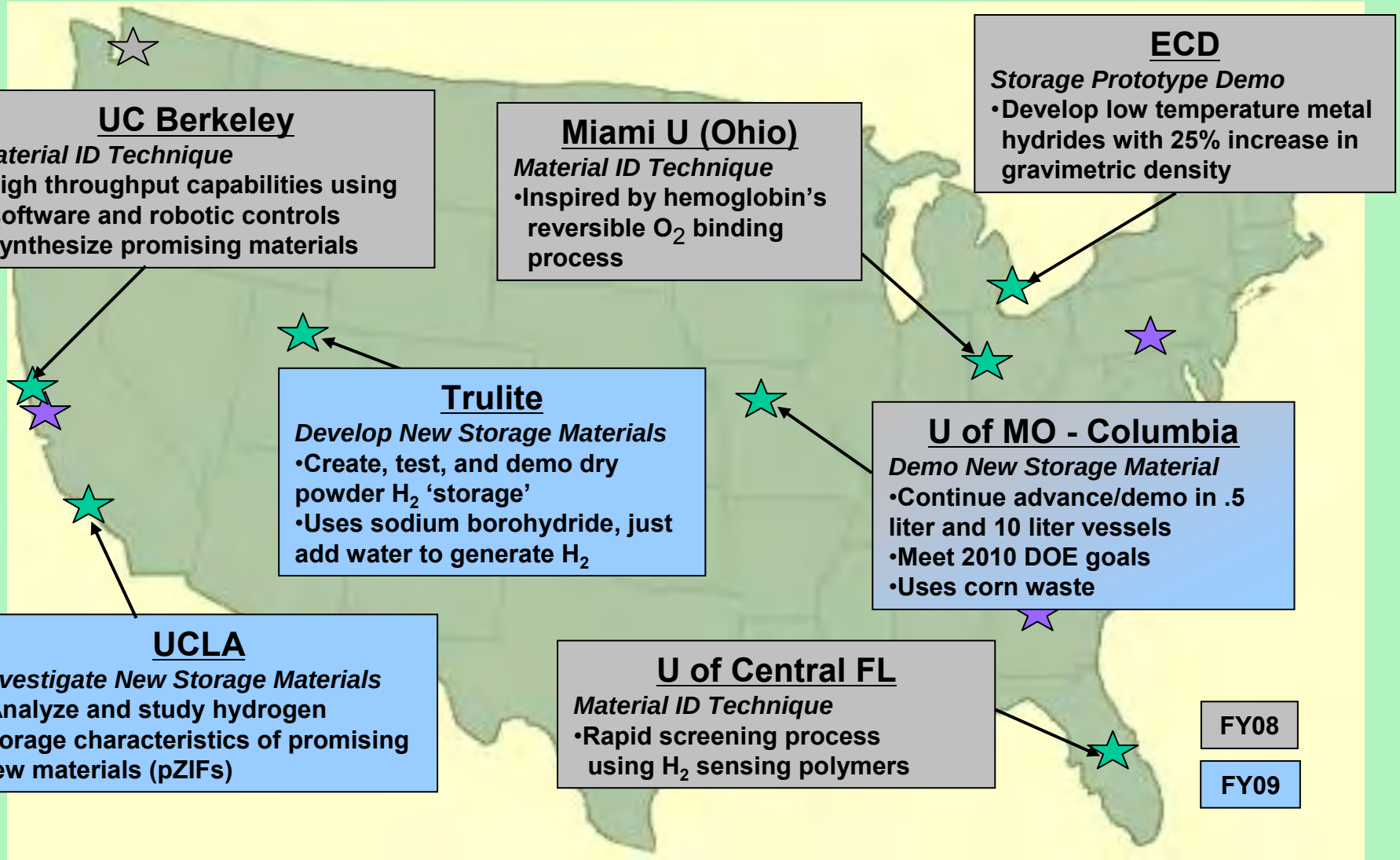
- Expand the technical requirements and/or capacity of ongoing DLA demonstration projects
- Focus on improving value proposition and „green" hydrogen production

Summary

- Our voracious use of fossil fuels is unsustainable, both economically and environmentally
- The complexity of the issue will require an array of solutions, and hydrogen & fuel cells can play a role
- Forklifts are a niche application that provide an opportunity to improve technologies through R&D
- DoD facilities and R&D allow for exploration of „green" hydrogen
- Long term goals:
  - Move the technologies from pilot to market to vehicles
  - Energy Security
  - Environmental sustainability

Backups

Solid Hydrogen Storage Initiative
Teaming with DOE and ONR



UC Berkeley
Material ID Technique
- High throughput capabilities using software and robotic controls
- Synthesize promising materials

Miami U (Ohio)
Material ID Technique
- Inspired by hemoglobin's reversible O_2 binding process

ECD
Storage Prototype Demo
- Develop low temperature metal hydrides with 25% increase in gravimetric density

Trulite
Develop New Storage Materials
- Create, test, and demo dry powder H_2 'storage'
- Uses sodium borohydride, just add water to generate H_2

U of MO - Columbia
Demo New Storage Material
- Continue advance/demo in .5 liter and 10 liter vessels
- Meet 2010 DOE goals
- Uses corn waste

UCLA
Investigate New Storage Materials
- Analyze and study hydrogen storage characteristics of promising new materials (pZIFs)

U of Central FL
Material ID Technique
- Rapid screening process using H_2 sensing polymers

FY08

FY09